

## DEVELOPMENT OF HIGH MISALIGNMENT CARBON SEALS: OVERVIEW

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### **Development of High Misalignment Carbon Seals (UEET)**

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## Seal Selection

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- TYPES CONSIDERED
  - Segmented circumferential seal
  - Face seal
- CONSIDERATIONS
  - Seal mass
    - Must operate with high inertia loads
  - Strength
    - Ability to survive potential high impact loads
  - Flexibility
    - Conformance to rotating surface



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This slide describes seal selection.  
Only contact seals were considered.

## **Segmented Circumferential Seal Chosen**

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- Low seal mass
  - Small cross-section made of light weight carbon material
- Conformability to shaft
  - Segmented design allows better tracking
- Simple design
  - No secondary seal with this design



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This slide discusses selection of the segmented circumferential seal. Historically face seals have large sections, thus greater mass. A face type seal requires a secondary device which could complicate operation at high misalignment.

## MATERIAL SELECTION

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- DESIRED PROPERTIES
  - High strength
  - Low elastic modulus
- CARBONE JP1000 SELECTED
  - Of the materials considered, **CARBONE JP1000** has the combination of **high flexural strength** and **low elastic modulus**

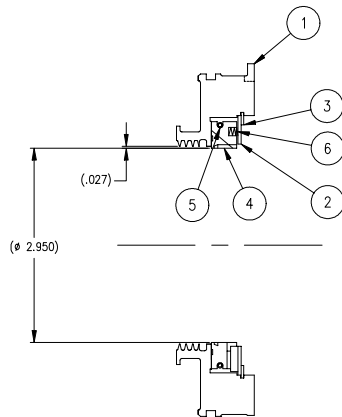


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An alternative material is a carbon-carbon type with very high strength in one direction and low modulus. Stein has no experience with this material.

# BASELINE SEAL



6	12	SSCY2645CS	COMPRESSION SPRING	INCO X-750	AMS 5698
5	1	SSCY13804-17	GARTER SPRING	INCO X-750	AMS 5698
4	1	SSCY13804-11	CIRCUMFERENTIAL SEAL RING	C-GPH	JP1000
3	1	SSCY81001-393	RETAINING RING	302 SST	-
2	1	SSCY13804-27	BACKPLATE	17-4 PH	AMS 5643
1	1	SSCY13804-21	SEAL HOUSING	17-4 PH	AMS 5643
ITEM REQ'D	PART NO.	LIST OF MATERIALS			
		DESCRIPTION	MAT'L.	MAT'L. SPEC	

← SHAFT ROTATION TO BE  
CLOCKWISE  
WHEN VIEWED FROM THIS DIRECTION

## NOTES:

1. THIS ASSEMBLY, WHEN ASSEMBLED ON A 2.950-2.949 DIA RUNNER, MUST NOT LEAK IN EXCESS OF 0.50 SCFM AT 35 ±1 PSIG AIR PRESSURE.



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## NASA/UEET GTF Shaft Seal Considerations

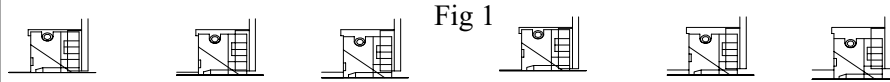


Fig 1

•Up to a .027 radial clearance between housing & shaft.  
 •Max radial movement to be .022  
**Normal design practice used for baseline testing**

•Up to a .047 radial clearance between housing & shaft.  
 •Max radial movement to be .042  
**Within normal design practice except face dam increased**

### ADVANTAGES

- Simple design
- Least costly
- Requires less space than other designs

### DISADVANTAGES

- High garter spring load
- Joint wear (at .047" radial clearance)
- Larger face and bore dam widths
- Lock slot and key wear
- Higher heat generation
- Higher bore wear



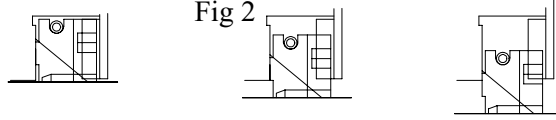
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This slide discusses the baseline seal for this program and lists its advantages and disadvantages. The seal has a longer than normal tongue and socket but is within current design practice.

## NASA/UEET GTF Shaft Seal Considerations

Fig 2



- Up to a .110 radial clearance between housing & shaft.
- Max radial movement to be .105

### Beyond normal design practice

#### Must look at:

1. Joint overlap must increase
2. Joint gap must be increased
3. Lock slot clearance must be increased
4. Bore and face dam must be increased
5. Undercut face dam in ID

#### Concerns

1. Joint wear
2. Lock slot wear
3. Extension spring movement
4. Compression spring

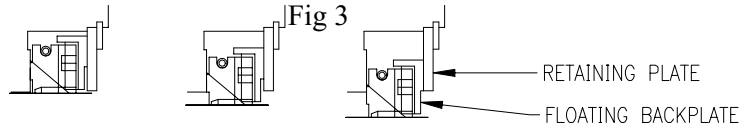


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This slide discusses the effect of trying to use current design practice for large shaft misalignments. There are too many concerns that are difficult to address and the configuration is not being considered.

## NASA/UEET GTF Shaft Seal Considerations



**New design concept** – Floating (counter bored) backplate up to a .110 radial clearance between housing & shaft. Max radial movement to be .105  
 •Eliminates joint, lock slot, spring movement concerns

**Must look at:**

- Anti rotation of floating backplate
- Friction between plates
- Face and bore dams must be increased
- Material for plates

**ADVANTAGES**

- Normal tongue and sockets to decrease breakage potential
- Normal tongue and socket gap
- Minimal joint wear
- Requires less space than Figure 4
- Minimal lock slot and key wear

**DISADVANTAGES**

- High garter spring load
- Complex, unproven backplate design
- More costly
- Larger face and bore dam widths
- Higher heat generation
- Higher bore wear



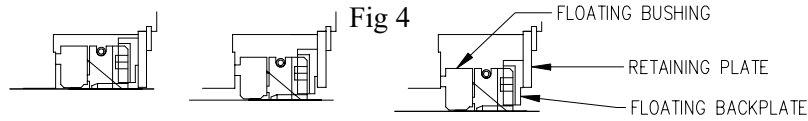
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This slide describes the design to be used for radial clearances above .040". To minimize inertia effects, light weight materials for the floating backplate will be evaluated. Hardenable material or hard coated surfaces will be considered to reduce friction between the floating backplate and retaining plate.



## NASA/UEET GTF Shaft Seal Considerations



**New design concept** – Floating (counter bored) backplate and floating bushing up to a .110 radial clearance between housing & shaft.

- Max radial movement to be .105
- Allows for near normal segmented seal design
- Must look at:**
  - Anti rotation of floating backplate
  - Friction between plates
  - Material for bushing and plates

### ADVANTAGES

- Normal circum. seal ring design
- Normal garter spring design
- Normal tongue and sockets to decrease breakage potential
- Normal tongue and socket gaps
- Minimal joint wear
- Normal size face and bore dam widths
- Less bore wear and heat generation
- Minimal lock slot and key wear

### DISADVANTAGES

- Complex design
- Backplate design unproven
- More costly
- Ceramic floating bushing
- Floating bushing unproven in aerospace applications
- Requires more space than other designs



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This slide describes an alternative design for the large clearances in this application. Addition of the floating bushing allows the segmented seal to operate as a normal clearance device. Stein has used floating bushings in industrial applications.